THE UNITED REPUBLIC OF TANZANIA

NATIONAL EXAMINATIONS COUNCIL

CERTIFICATE OF SECONDARY EDUCATION EXAMINATION

131/3A **PHYSICS 3**

ALTERNATIVE A PRACTICAL

(For Both School and Private Candidates)

Time: 3 Hours 10 Minutes **ANSWERS** **Year : 2004**

Instructions

1. This paper consists of three (3) questions.
2. Answer all questions
3. Non-programmable calculators may be used.
4. Communication devices and any unauthorised materials are **not** allowed in the examination room.
5. Write your **Examination Number** on every page of your answer booklet(s).

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1. You are required to determine the coefficient of rigidity μ of the wire provided.

(a) Tie the wire at the centre of the rod so that the rod hangs horizontally. Suspend the rod from the retort stand so that a length L = 50 cm of the wire is used. Ensure the wire is straight.

This sets up a torsional pendulum with rod suspended on the wire.

(b) Start the rod to oscillate horizontally by giving it a small angular displacement from one end. Measure the time for ten oscillations and hence find the periodic time T. Repeat for L = 40, 30, 20, and 10 cm. Tabulate results.

Suppose the following experimental results are obtained:

L (cm)	Time for 10 osc (s)	Period T (s)	T^2 (s^2)
50	20.0	2.00	4.00
40	17.9	1.79	3.20
30	15.5	1.55	2.40
20	12.7	1.27	1.61
10	9.0	0.90	0.81

(c) Measure the radius a of the wire, the mass M of the rod, and the length d of the rod.
Suppose:
a = 0.50 mm = 0.0005 m
M = 0.50 kg
d = 0.60 m

(d) Plot a graph of T^2 against L and use it to find the coefficient of rigidity μ of the wire.

The relation is:
$T = 2\pi \sqrt{(2IL / (\mu a^4 d))}$

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Squaring:

$T^2 = (8\pi^2 I / \mu a^4 d) L$

So gradient = $(8\pi^2 I) / (\mu a^4 d)$.

Moment of inertia of rod about centre:

$I = Md^2 / 12 = (0.50 \times 0.60^2) / 12 = 0.015$ kg·m².

From table, slope of graph:

Using (L = 0.50 m, $T^2 = 4.00$) and (L = 0.10 m, $T^2 = 0.81$):

Slope = $(4.00 – 0.81) / (0.50 – 0.10) = 3.19 / 0.40 = 7.98$ s²/m.

Now equating:

$7.98 = (8\pi^2 \times 0.015) / (\mu \times (0.0005)^4 \times 0.60)$.

Denominator term: $(0.0005)^4 \times 0.60 = 6.25 \times 10^{-14}$.

Numerator: $8\pi^2 \times 0.015 \approx 1.185$.

So $7.98 = 1.185 / (\mu \times 6.25 \times 10^{-14})$.

$\mu = 1.185 / (7.98 \times 6.25 \times 10^{-14})$.

$\mu = 1.185 / (4.987 \times 10^{-13}) \approx 2.38 \times 10^{12}$ N/m².

(e) Units of μ: N m^{-2} (Pascal).

2. You are required to determine the refractive index η of the liquid L provided.

(a) (i) Place the mirror on the base of the stand and adjust the position of the pin P_1 until the point coincides with its image. Measure distance P_1A.

(ii) Repeat two more times and record values.

Suppose:

P_1A = 15.0 cm, 15.2 cm, 14.8 cm → Average = 15.0 cm.

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(b) (i) Pour liquid into mirror, adjust pin until coincidence with image. Measure P_2A.

(ii) Repeat two more times.

Suppose:

P_2A = 11.0 cm, 10.9 cm, 11.1 cm → Average = 11.0 cm.

(c) Measure depth of liquid AB. Suppose:

AB = 5.0 cm.

(d) Use formula:

$P_2A = (P_1A / \eta) + (AB / \eta)$.

$\eta = (P_1A + AB) / P_2A$.

$= (15.0 + 5.0) / 11.0 = 20.0 / 11.0 = 1.82$.

(e) State any three sources of error.

Parallax error when aligning pin with its image.

Distortion of image due to surface ripples of the liquid.

Inaccurate measurement of depth AB due to irregular meniscus.

3. You are required to determine the electrical resistivity of the wire labelled X.

(a) (i) Set up the slide-wire metre bridge as illustrated in fig. 2 below, where E is an accumulator, G a galvanometer, K a switch and J the jockey.

This ensures a Wheatstone bridge arrangement for comparing resistances.

(ii) Connect a length y = 10 cm of the wire labelled Y to the right hand gap of the metre bridge, to the left hand gap connect a length x of wire labelled X, and balance at the 50 cm mark. Measure x.

Suppose balance length found is x = 12 cm.

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(b) Repeat for y = 20, 30, 40, 50, and 60 cm and record the corresponding x.

Table of results:

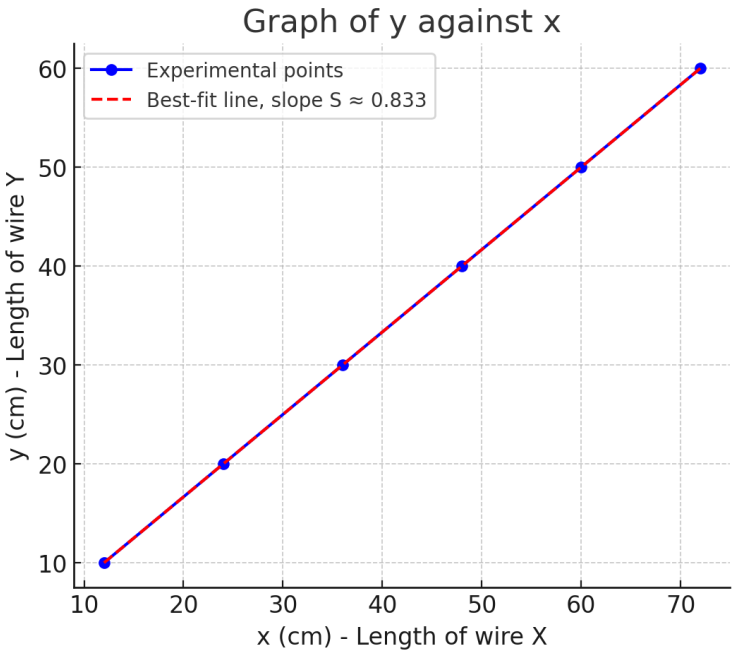
y (cm)	x (cm)
10	12
20	24
30	36
40	48
50	60
60	72

(c) (i) Record values of x and y in a table. (Done above).

(ii) Measure and record diameters dx and dy of wires X and Y.

Suppose: dx = 0.60 mm = 0.0006 m, dy = 0.50 mm = 0.0005 m.

(d) Plot a graph of y against x and determine slope S.



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From table, graph is a straight line through origin with slope S = y/x.

Using (y = 60, x = 72):
Slope S = 60 / 72 = 0.833.

(e) Using relation

$y = (\rho x / \rho y) \times (dy/dx)^2 \times x$

So slope $S = (\rho x / \rho y) \times (dy/dx)^2$.

Therefore,

$\rho x = \rho y \times (S / (dy/dx)^2)$.

Suppose $\rho y = 1.7 \times 10^{-8}$ Ω·m (copper).

$(dy/dx)^2 = (0.0005 / 0.0006)^2 = (0.833)^2 = 0.694$.

So $\rho x = 1.7 \times 10^{-8} \times (0.833 / 0.694)$.

$= 1.7 \times 10^{-8} \times 1.20$

$= 2.04 \times 10^{-8}$ Ω·m.

(f) State any two sources of errors in this experiment.

Parallax error when reading balance point on slide wire.

Inaccurate measurement of diameters dx and dy using micrometer screw gauge.

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